

REMARKS/ARGUMENTS

Favorable reconsideration of this application as presently amended and in light of the following discussion is respectfully requested.

Claims 1, 3-26, 29-39, 41-52, 55-56, 59-62, 65 and 78-82 are presently active in this case, Claims 1, 3, 8, 25, 29, 34-37, 41-42, 45-46, 49-50, 52, 55-56 and 59-60 amended, and Claims 2, 27-28, 40, 44, 53-54, 57-58 and 63-64 canceled and Claims 79-82 added by way of the present amendment.

In the outstanding Official Action, Claims 27, 28, and 52 were rejected under 35 U.S.C. § 112, second paragraph; Claims 1-4, 6, 11-13, 20-23, 27, 28, 31, 34-36, 38, 52, 53 and 64 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,420,279 to Ono et al. in view of either U.S. Patent Publication 2003/0013320 A1 to Kim et al. or U.S. Patent No. 6,042,652 to Hyun et al., further in view of U.S. Patent Publication 2002/0157611 A1 to Bondestam et al. (the primary combination of references); Claims 5, 7, 25, 26 and 30-33 were rejected under 35 U.S.C. § 103(a) as being unpatentable over the primary combination of references and further in view of U.S. Patent Publication 2003/0031793 to Chang et al. and U.S. Patent No. 6,346,477 to Kaloyeros et al.; Claims 8 and 10 were rejected under 35 U.S.C. § 103(a) as being unpatentable over the primary combination of references and further in view of U.S. Patent Publication 2001/0054769 to Raaijmakers et al.; Claim 9 was rejected under 35 U.S.C. § 103(a) as being unpatentable over the primary combination of references and further in view of Raaijmakers et al., Chang et al., and Kaloyeros et al.; Claim 24 was rejected under 35 U.S.C. § 103(a) as being unpatentable over the primary combination of references and further in view of U.S. Patent No. 6,572,705 to Suntola et al.; Claim 29 was rejected under 35 U.S.C. § 103(a) as being unpatentable over the primary combination of references and further in view of U.S. Patent Publication 2003/0134038 to Paranjpe; Claim 37 was rejected under 35 U.S.C. § 103(a) as being

unpatentable over the primary combination of references and further in view of U.S. Patent No. 6,607,973 to Jeon; Claims 58-60 were rejected under 35 U.S.C. § 103(a) as being unpatentable over the primary combination of references and further in view of U.S. Patent Publication 2002/0182320 to Leskela et al.; Claims 61-62 were rejected under 35 U.S.C. § 103(a) as being unpatentable over the primary combination of references and further in view of U.S. Patent Publication 2003/0049372 to Cook et al.; and Claim 78 was rejected under 35 U.S.C. § 103(a) as being unpatentable over the primary combination of references and further in view of U.S. Patent No. 6,946,336 to Pang et al., U.S. Patent Publication 2004/0211357 to Gadgil et al. or U.S. Patent No. 6,548,424 to Putkonen.

With regard to the rejection under 35 U.S.C. § 112, second paragraph, Claims 27 and 28 have been canceled and Claim 52 has been amended to correct the informalities noted in the Office Action. Therefore the rejection is believed to be overcome.

Turning now to the merits, Applicants' invention is directed to forming a metal containing film on a plurality of substrates in a batch-type processing system using an ALD process. As discussed in Applicants' specification, the formation of metal containing films has generally been limited to single substrate processes due to the difficult problem of providing uniform process results at different wafer positions in the processing chamber. However, the present inventors have conducted experiments to analyze the effect of different process parameters on a batch process for depositing films including HfO₂. Figures 10-13 of Applicants' specification show processing parameters that were discovered by the present inventors to provide improved uniformity of process results across a batch of wafers. Applicants' independent claims are directed to these discovered process parameters.

Specifically, Applicants' independent Claim 1, as amended recites forming a hafnium-containing film by heating a plurality of substrates to a temperature of approximately 180°C. Support for this limitation is provided by Figure 13 of Applicants'

specification as originally filed, and text relating thereto. As seen in Figure 13, batch deposition of a hafnium-containing film at approximately 180°C provides a WIW uniformity that is substantially similar among the top, center and bottom wafers in a tier wafer processing system. Thus, Applicants have identified that 180°C is a desired temperature for performing the claimed batch type deposition process.

In contrast, the primary cited references do not disclose performing deposition of a hafnium-containing film in a batch type processing system at 180°C. Of the primary cited references, only Kim et al. and Hyun et al. disclose atomic layer deposition in a batch type processing system. However, Kim et al. discloses deposition only at 375°C, and the cited reference to Hyun et al. does not include any discussion of deposition temperature at all.

The primary cited references to Ono et al. and Bondestam et al. disclose single wafer processing systems. While Ono et al. discloses an example wherein an ALD process is performed at approximately 180°C,¹ this reference does not disclose any advantage of operating at this temperature for a single substrate, let alone for a batch of substrates. Similarly, the cited reference to Bondestam et al. discloses a variety of operating temperatures for a single substrate ALD process, without any suggestion of operating a batch type ALD processing system at any particular temperature.

The remaining secondary references are cited in the Office Action for their teaching of claimed features in the dependent claims, and do not correct the deficiencies of the primary cited references noted above. Specifically, of the eleven additional references cited, only Suntola et al., Paranjpe and Cook et al. disclose batch type processing systems. However, Suntola et al. and Paranjpe et al. do not discuss processing temperature at all. While the cited reference to Cook et al. includes some discussion of operating temperatures, this reference is directed to a chemical vapor deposition process, and not an atomic layer deposition process.

¹ See Ono et al. at column 3, lines 59-65.

The remaining eight cited references are directed to single wafer processing, and therefore provide no better disclosure than the Ono et al. and Bondestam et al. references noted above. Specifically, these references do not provide any hint or suggestion for operating a batch type ALD processing system at 180°C. Applicants submit that without a suggestion of this type, one of ordinary skill in the art would not be motivated to apply an operating temperature of a single substrate processing system to that of the claimed batch type processing system. Therefore, Applicants' Claim 1 patentably defines over the cited references.

Applicants' new independent Claim 79 recites a method of forming a metal containing film including, *inter alia*, that a total time of a cycle of flowing a pulse of hafnium-containing precursor and flowing a pulse of reactant gas in the process chamber is less than 30 seconds and is repeated less than twenty times. Support for this limitation is provided by Figures 10 and 11 of Applicants' specification as originally filed. As seen in Figure 10, providing a total cycle time of less than 30 seconds results in greater similarity in film thickness among the top, center and bottom wafers in a tier type processing stack. Figure 11 shows that limiting the number of cycles to less than twenty provides greater similarity in film thickness among the top, center and bottom wafers in a tier type processing stack.

The batch processing references to Shun et al., Kim et al., Suntola et al., Paranjpe et al., and Cook et al. do not include any analysis or discussion of the overall cycle time or number of cycles in relation to consistency of film thickness across the batch. Indeed, these references do not discuss consistency of any parameter across the batch in a tier type ALD processing system. Still further, the remaining cited references relate only to a single wafer processing system, and therefore cannot provide any suggestion of exposure time or cycles time for providing consistent process results across the batch type processing system.

Applicants independent Claim 82 recites that the plurality of substrates are placed only from a middle surface to a lower surface of the tier substrate holder. As seen in Applicants' Figures 10 and 11, Applicants have further discovered that process results are substantially constant for substrates positioned between the middle position and lower position in a substrate holder. Thus, one of ordinary skill in the art would find support for Claim 82 at least in Figures 10 and 11. Further, as noted above, none of the cited references disclose this consistency of processing. Therefore, Applicants' Claim 82 also patentably defines over the cited references.

Finally, Applicants note that those batch type processing parameters now recited in independent Claims 1, 79 and 82 cannot be said to be "obvious to optimize." It is settled law that a particular parameter must first be recognized as a result effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation.² As discussed above, those cited references that do disclose a batch type processing system do not include any discussion of changing parameters of the process performed therein in order to provide consistent results across the batch. Thus, while the process parameters of Applicants' independent claims are known process parameters, one of ordinary skill in the art would not be motivated to optimize these parameters without first discovering that such parameters affect consisted batch process results. This discovery is gained only through the benefit of Applicants' disclosure.

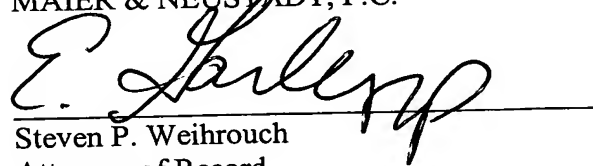
For the reasons discussed above, Applicants' Claims 1, 79 and 82 patentably define over the cited references. As the remaining claims in this case depend from one of these independent claims, the remaining dependent claims also patentably define over the cited references.

² See In re Antonie, 559 F.2d 618, 195 USPQ 6 (CCPA 1977).

Consequently, in view of the present amendment, no further issues are believed to be outstanding in the present application and the present application is believed to be in condition for formal allowance. An early and favorable action is therefore respectfully requested.

Respectfully submitted,

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